Beryllium Metal Machining Engineering Controls

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Design Criteria

- Minimum of 500 FPM capture velocity for dry machining operations
- Provide secondary confinement where practical
- Minimum of 125 FPM face velocity on enclosures

Beryllium Technology Facility

- Engineering controls consist of two exhaust systems
  - General building exhaust
    - HEPA filtered
  - Process exhaust
    - Transport velocities of 4000 FPM
    - Two additional filtration stages
      - Local centrifugal cyclone collectors
      - Cartridge filter house

General Building Exhaust System

- Exhausts air from room near floor
- Exhausts laboratory hoods
  - Maintains 125 FPM face velocity
- Exhausts machines
- Maintains building pressure

Process Exhaust System

- Design features
  - –Flanged connections
  - –Long radius elbows
  - –45° branch inlets
  - –Full port shut-off valves
  - –Flex hose
    - Heavy duty
    - See-thru
    - Smooth inner wall

Process Exhaust System

- Design features
  - Two connections for each machine
    - Capture hood
    - House keeping hose

Process Exhaust System

- Design features
  - –Noise reduction
    - Long transitions
    - Duct wrap with smooth covering
  - –Centrifugal Cyclone Collectors
    - Chip collection cans
      - Double valve
      - Site glass

Process Exhaust System

- Areas for improvement
  - –Cyclones
    - One per machine
      - Size for actual flow
    - Beryllium ware plate
    - Stainless steel construction with polished inner surface
    - Better can removal system

General Exhaust System

- Example of poor design
  - Long run of flex hose
  - Exposed slide damper

Wet Machining Operations

- Band saw
- Wire EDM
- Plunge EDM

Wet Machining Operations

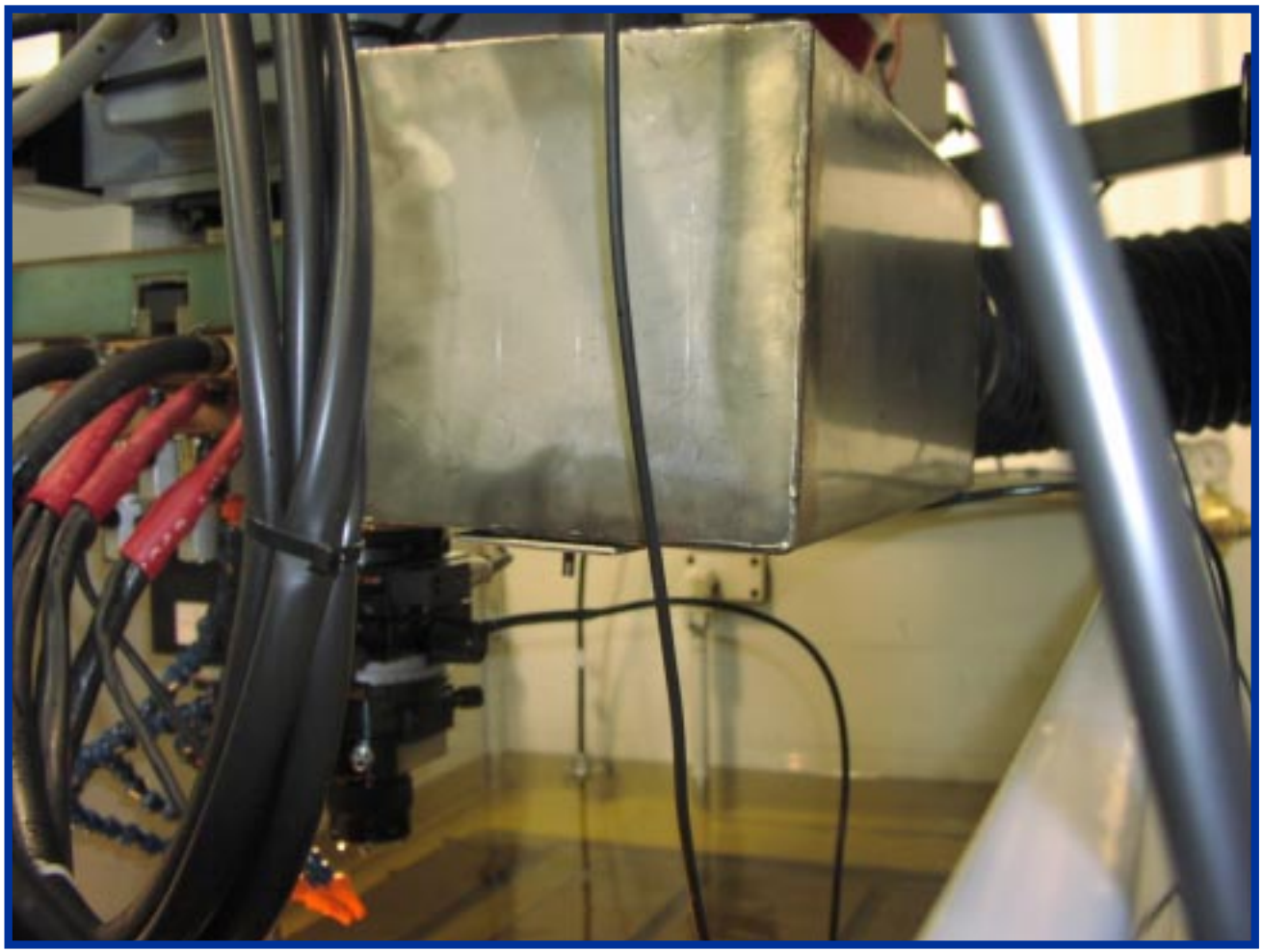
- Design features
  - Connected to general exhaust system only
  - Inlets designed for 2000 FPM
  - Designed to prevent the carry-over of liquids into main duct
  - Length of flex duct kept to a minimum
  - Exhaust control valve for each machine

Band Saw With Exhaust Hood

Flanged Duct Inlet On Wire EDM

- Located to sweep air across top of liquid surface

Slotted Hood On Plunge EDM



Slotted Hood On Plunge EDM

Dry Machining Operations

- CNC Machines
  - Hardinge Machining Center
  - T Base Lathe
- Manual Machines
  - Hardinge Tool Room Lathe
  - Bridgeport Mill

CNC Machines

- Hardinge Machining Center
  - Fully enclosed
  - Tools mounted on a turret
- T Base Lathe
  - Enclosure only around spindle

Hardinge Machining Center

- Design features
  - Connected to both process and general exhaust systems
  - Face velocity across door opening maintained at 125 FPM
  - Process exhaust connected to tool that is in use

Hardinge Machining Center

Slot Hood On Back Of Hardinge CNC

- Design features
  - –Uses existing access panel location
  - –Provides for a uniform velocity through front door opening

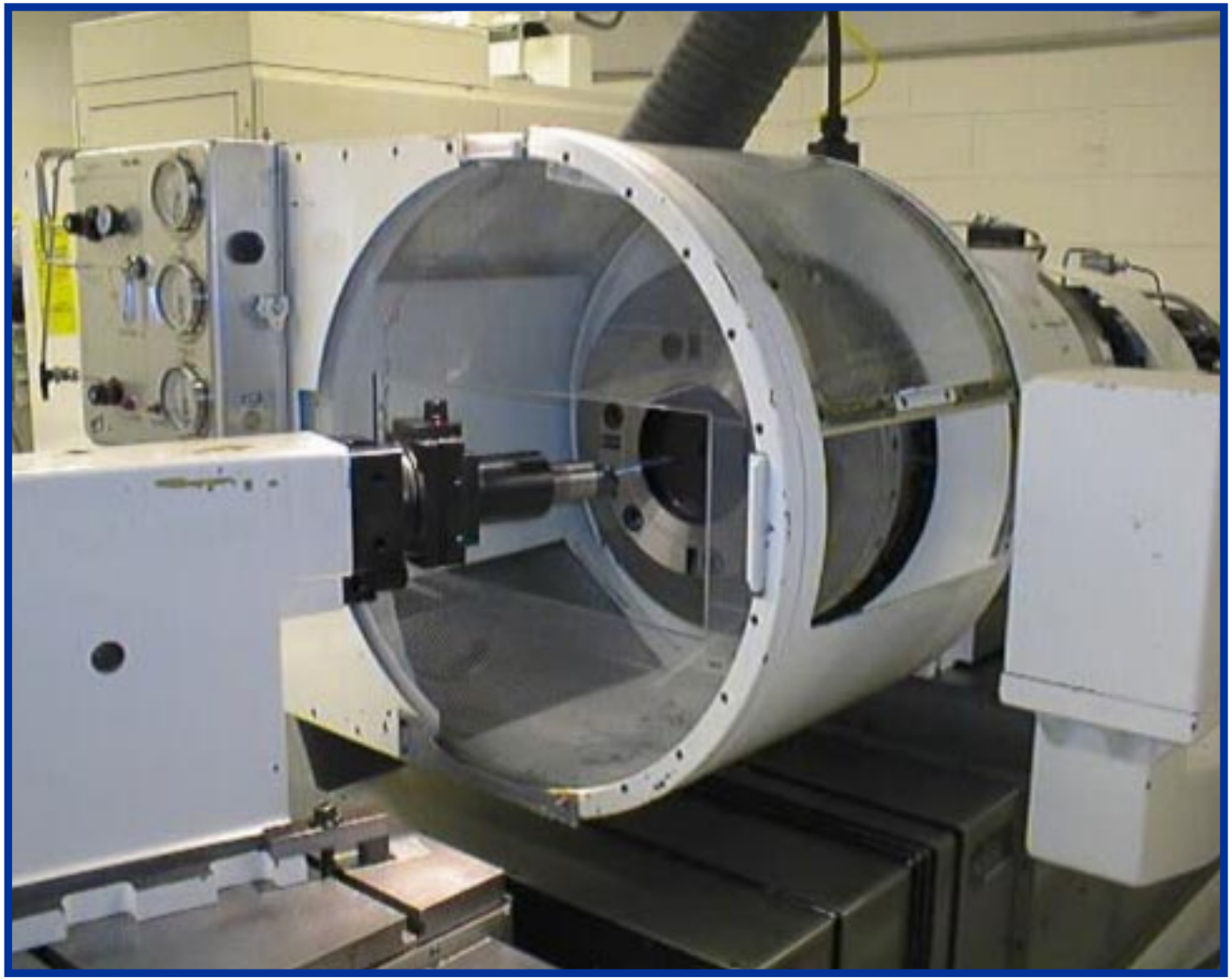
Process Exhaust Connection For Hardinge Machining Center

Exhaust Piping Used In Hardinge Machining Center

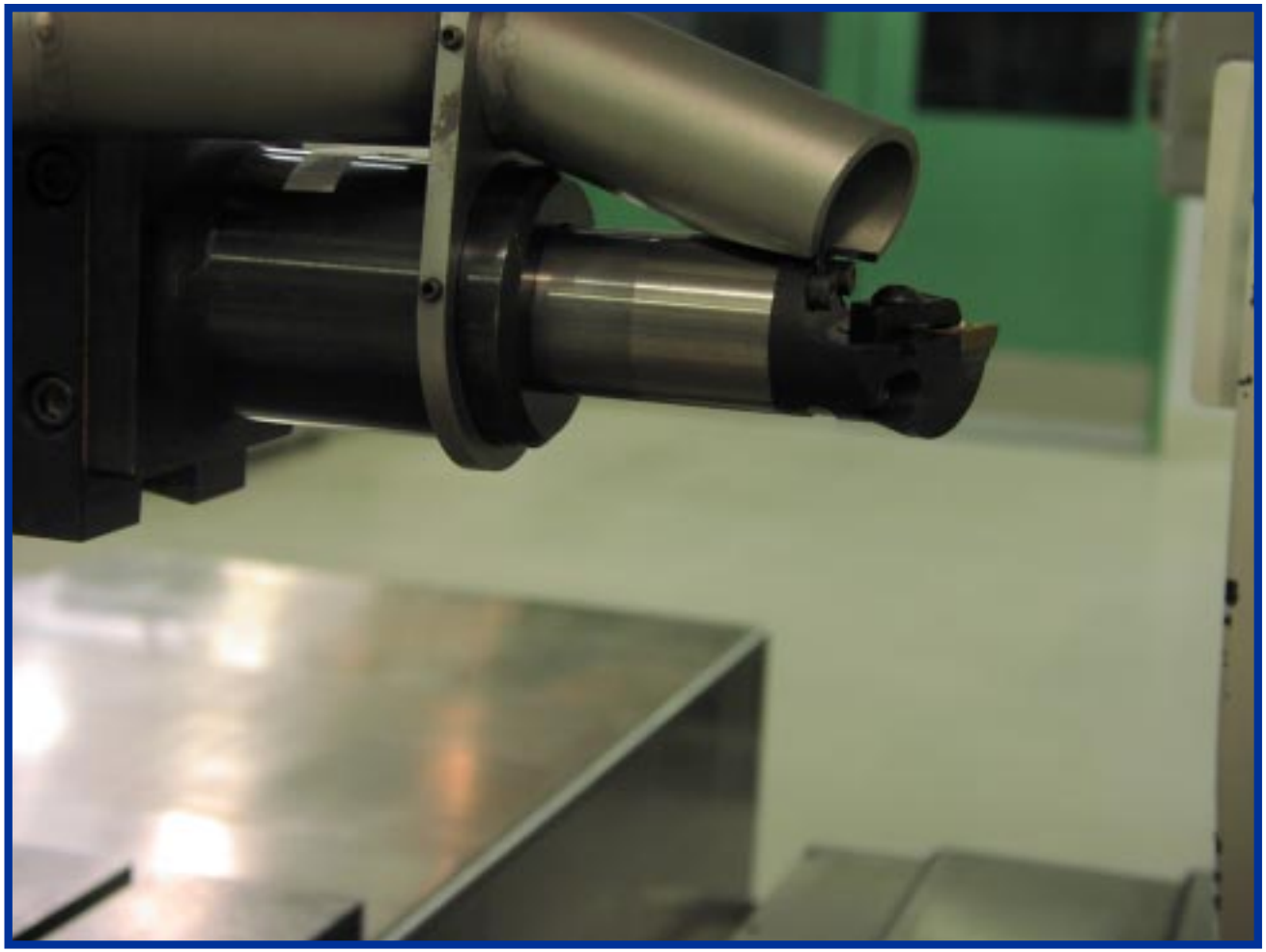
T Base Lathe

- Design features
  - Connected to both process and general exhaust systems
    - Uses existing enclosure for secondary confinement
    - Adds process exhaust to cutting tool

T Base Lathe



Inlet Nozzle For T Base Lathe Tool



Manual Machines

- Difficult to enclose
  - Hardinge Tool Room Lathe
    - Close operator involvement
    - Controls located on movable part of machine
  - Bridgeport Mill
    - Close operator involvement
    - Wide range of movement

Hardinge Tool Room Lathe

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Bridgeport Mill

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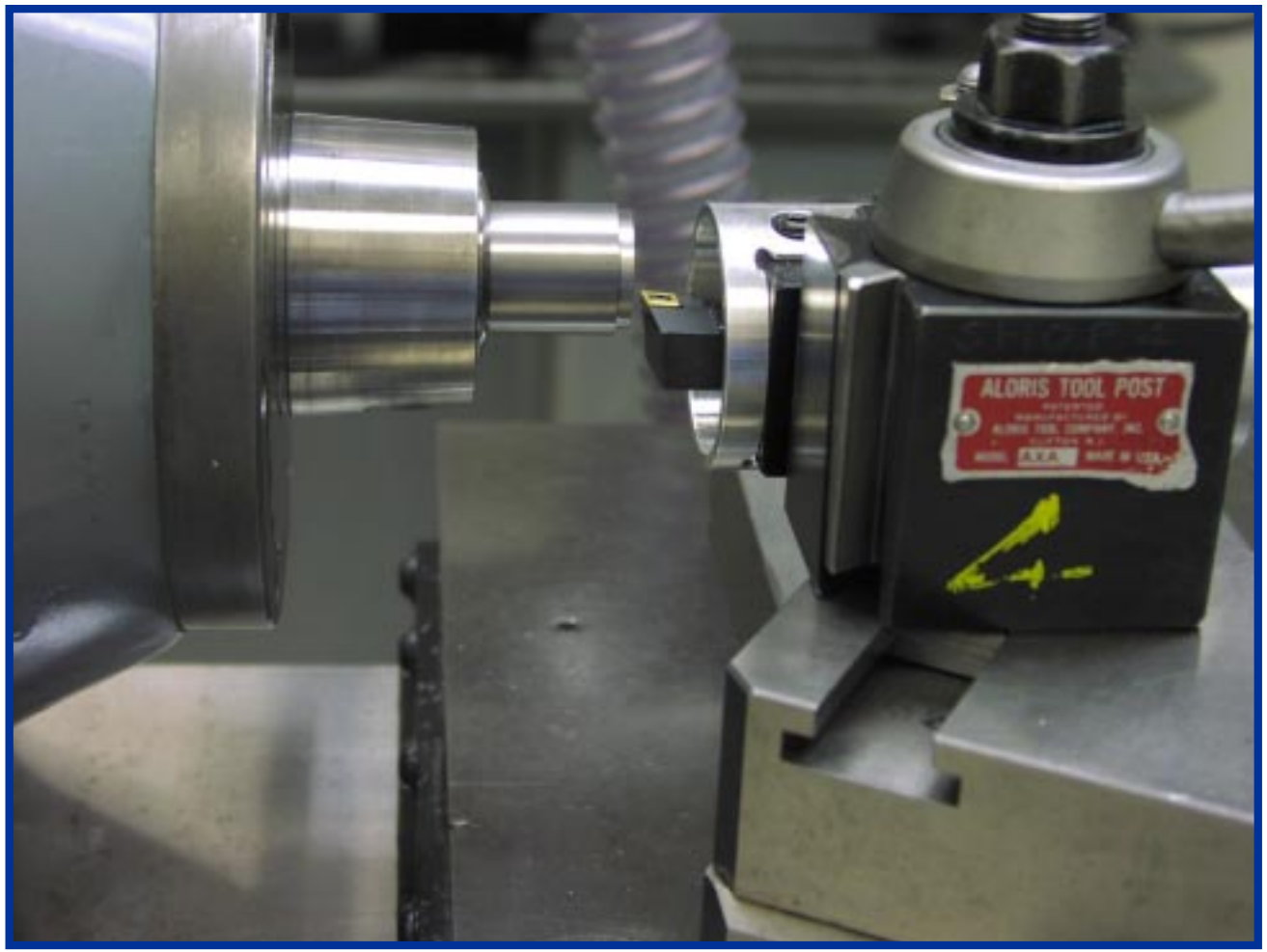
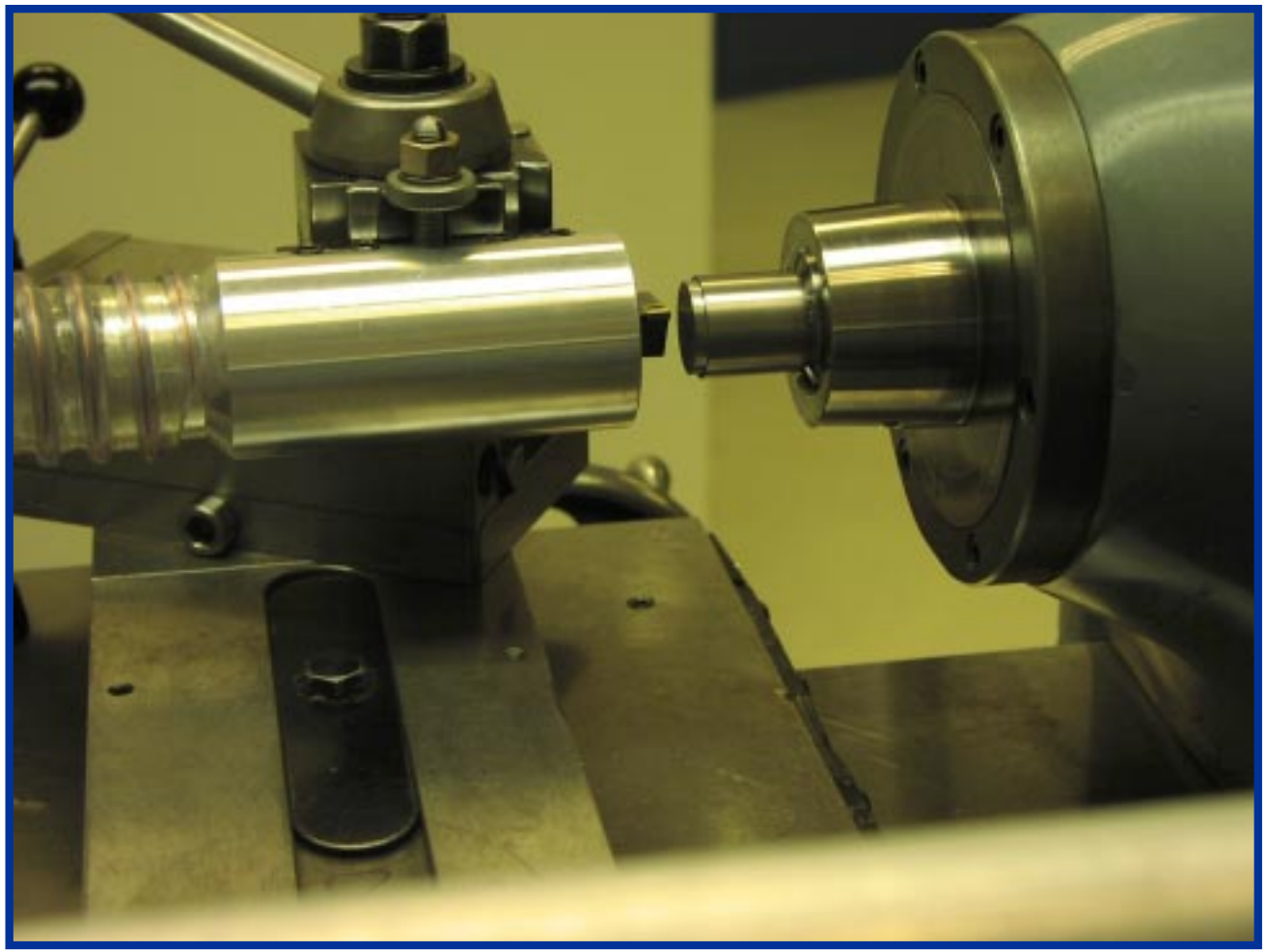
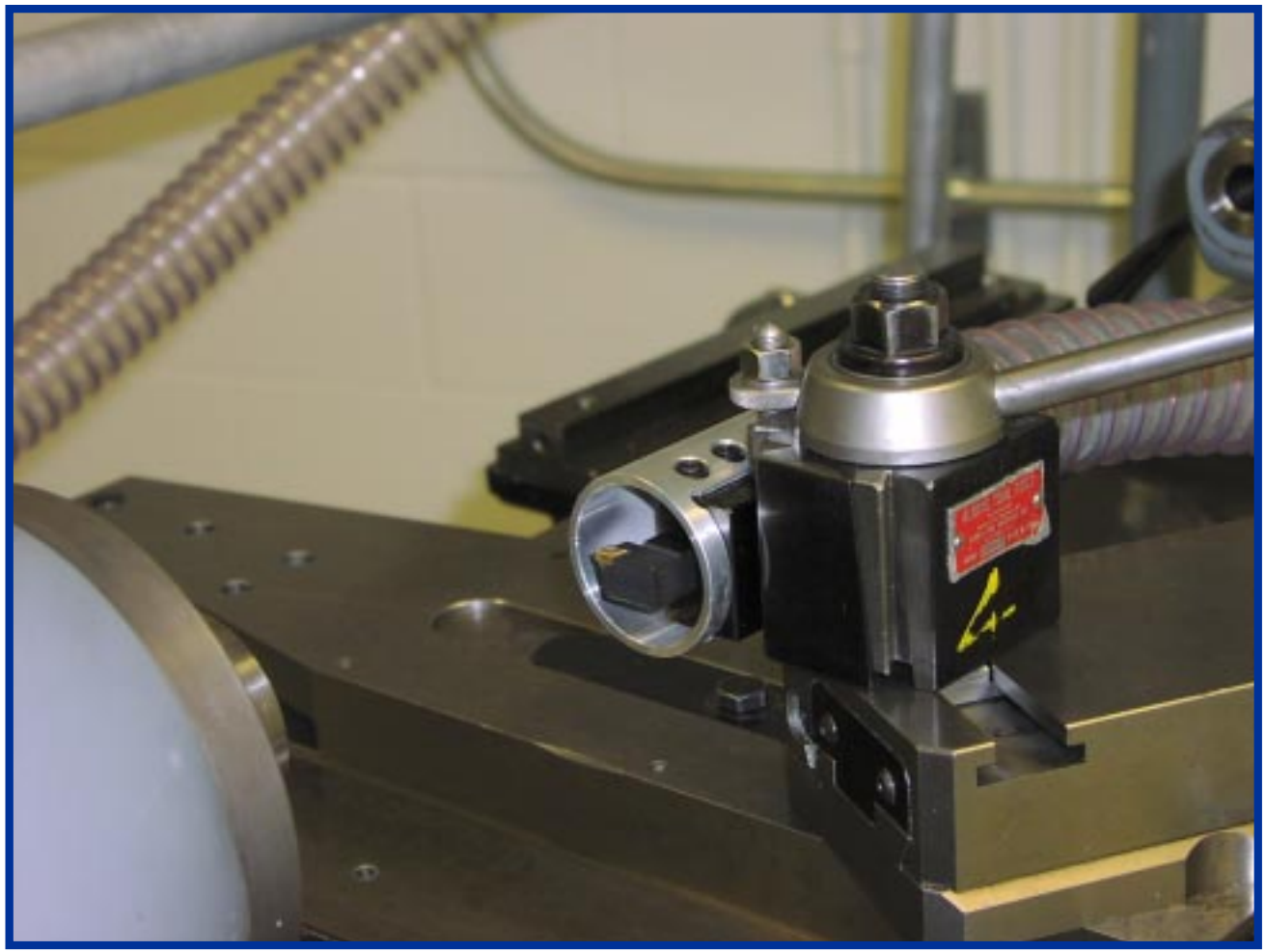
Inlet Nozzle On Hardinge Lathe



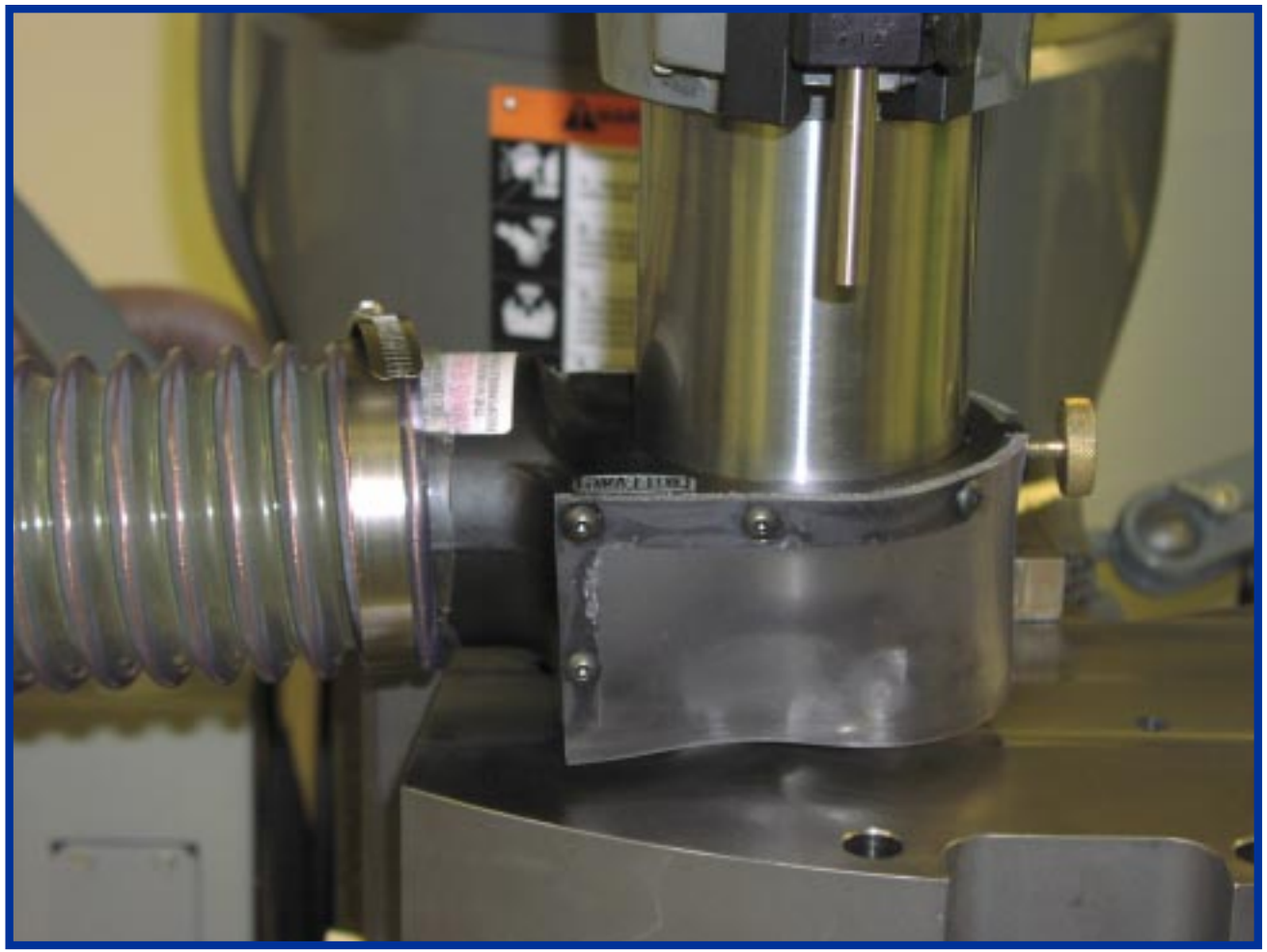
Inlet Nozzle On Hardinge Lathe



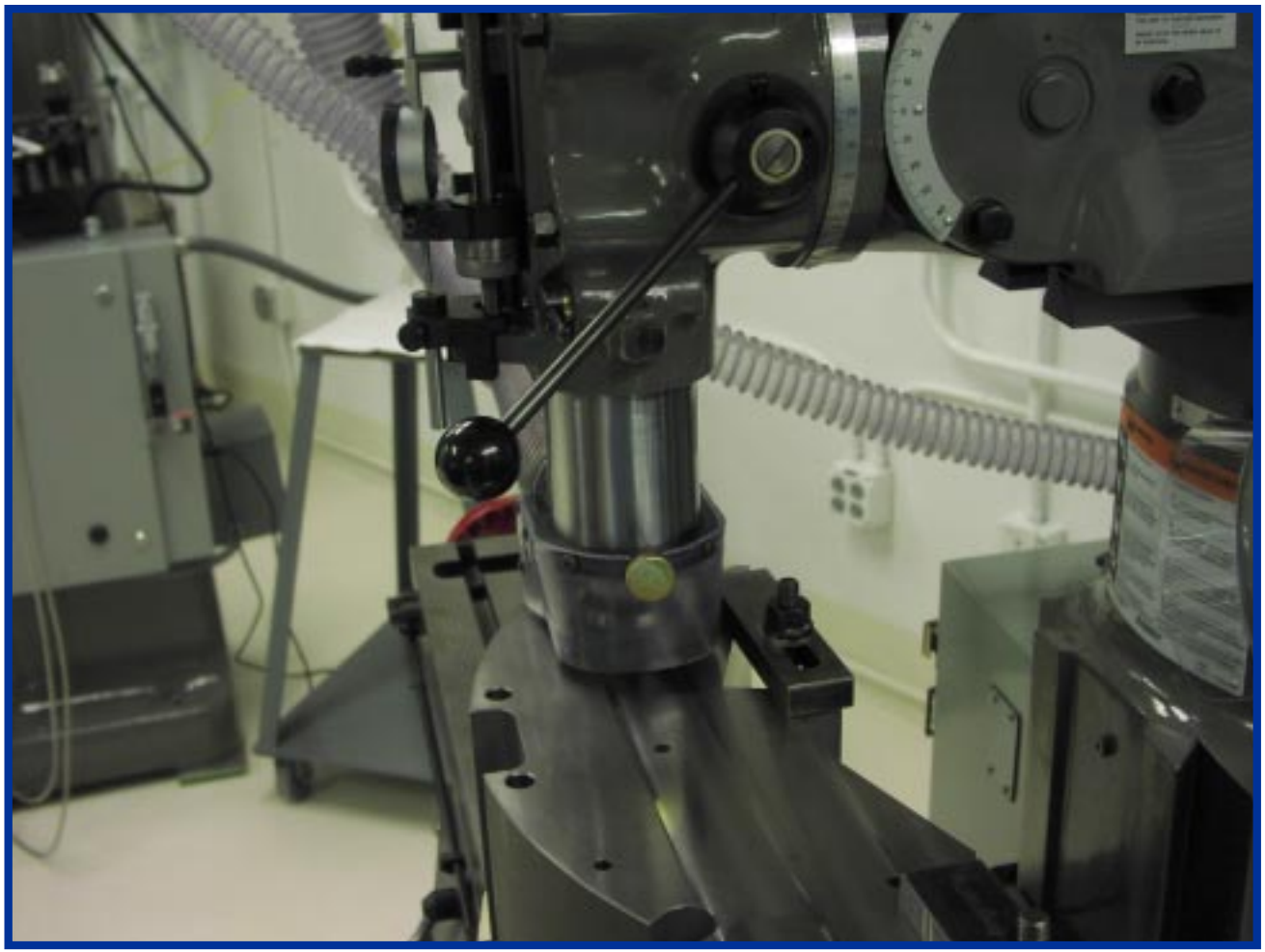
Inlet Nozzle On Hardinge Lathe



Capture Hood On Bridgeport Mill



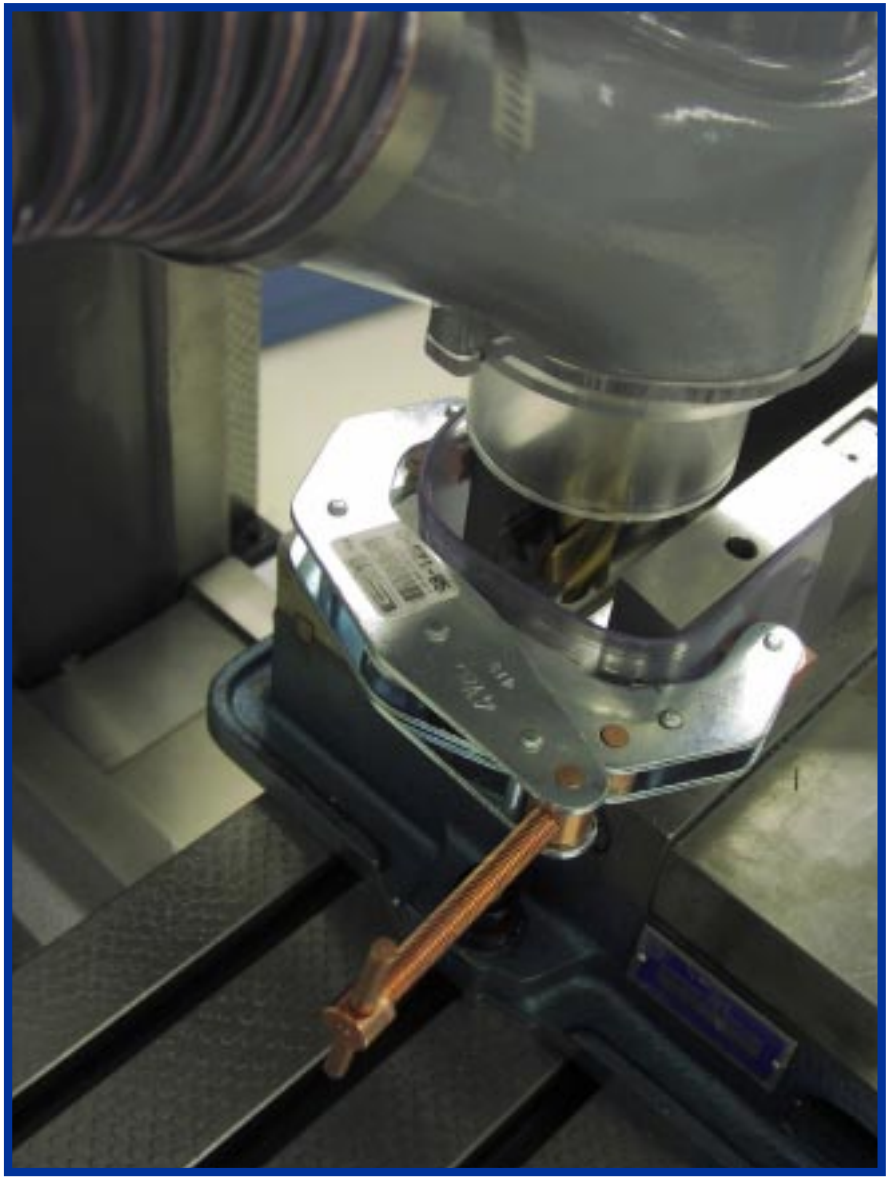
Capture Hood On Bridgeport Mill



Capture Hood On Bridgeport Mill

Part being used as part of capture hood

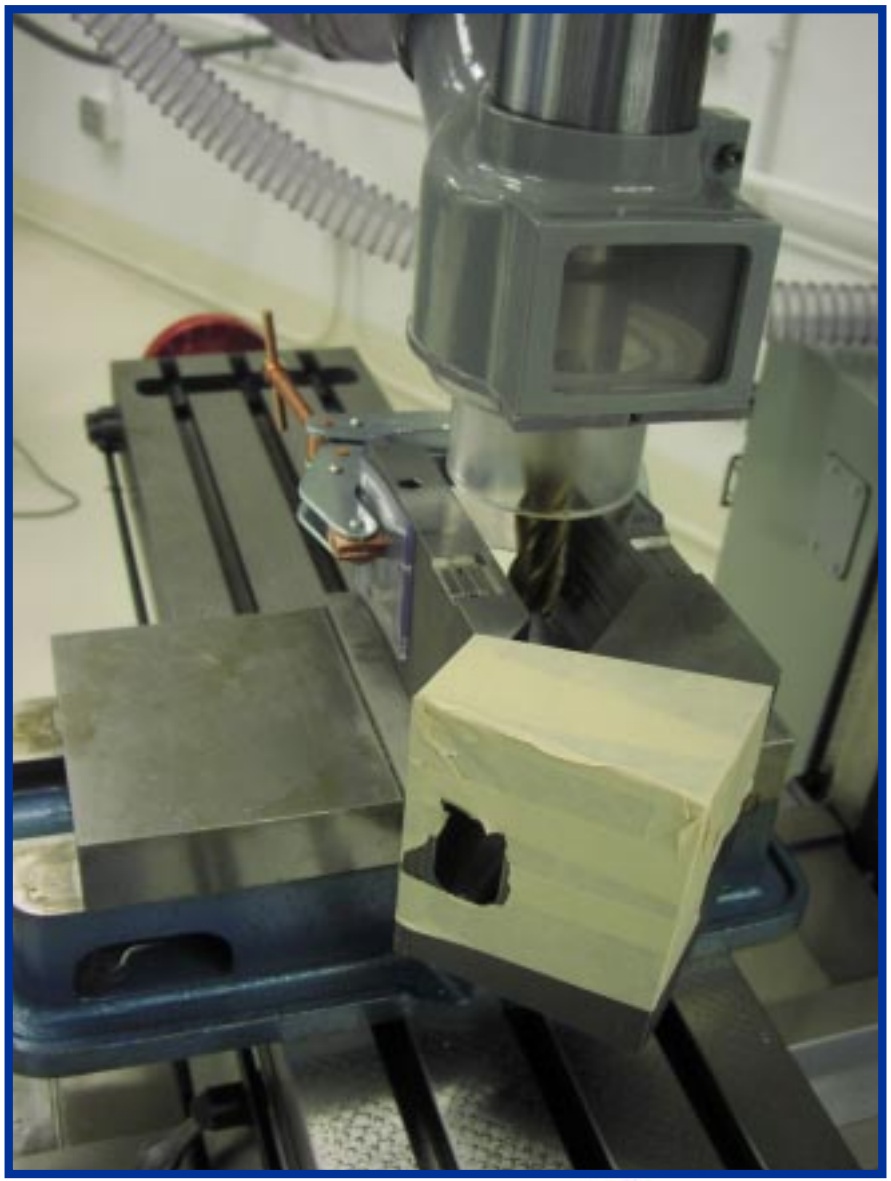
- Shows importance of machinists being innovative



Capture Hood On Bridgeport Mill

Part being used as part of capture hood

- Shows importance of machinists understanding air flow



Are Engineering Controls Working?

- Personal breathing zone (PBZ) samples
  - 744 BZS collected and analyzed over a nine month period
  - All below limit of quantification (LOQ) of 0.03 $\mu g/m^3$